CLEEN (Continuous Lower Energy, Emissions and Noise) Program

Overview

Presented to: CLEEN Consortium

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Office of Environment and Energy

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Aviation Environmental Goals and Challenges

NextGen goal to increase mobility is dependent upon addressing & mitigating aviation environmental impacts & dealing with related energy issues

NextGen environmental goals

- Absolute reduction of significant ***community noise*** and ***air quality*** emissions impacts
- Improve NAS ***energy*** efficiency and, supply of and access to, alternative fuel sources
- Achieve carbon neutral growth by 2020 compared to 2005 baseline for ***climate change***
- Reduce significant aviation impacts associated with ***water quality***

5-Pillar approach to develop solutions

P1 Improved science and modeling

P2 Accelerated maturation of new aircraft technologies

P3 Renewable fuels

P4 Accelerated ATM Improvements and Efficiencies

P5 Policies, Environmental Standards, Market Based Measures and Environmental Management System

FAA CLEEN Program

- Address NextGen environmental goals in partnership with industry
- Mature and demonstrate promising energy efficient, clean and quiet technologies
- Advance sustainable alternative fuels for aviation
- Assess technology suitability for retrofit or re-engine
- Meet national R&D goals

CLEEN Program* Goals

Develop and demonstrate (TRL 6-7) certifiable aircraft technology

CORNERS OF THE TRADE SPACE	CLEEN (N+1) (2015)** Ref: B737/CFM56-7B	N+2 (2020)*** Ref: B777-200/GE-90	N+3 (2025)***
Noise (cum below Stage 4)	-32 dB	-42 dB	-71 dB
LTO NO_x Emissions (Below CAEP 6)	-60%	-75%	better than -75%
Aircraft Fuel Burn	-33%	-50%	better than -70%

* Consistent w/ National Aeronautics Research and Development Plan

** EIS beginning in 2015

*** Technology Readiness Level for key technologies = 4-6

CLEEN Program Goals (continued)

Advance use of "drop-in" renewable alternative fuels

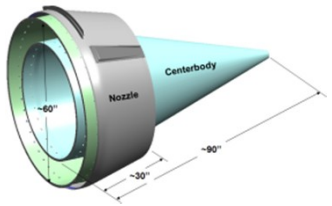
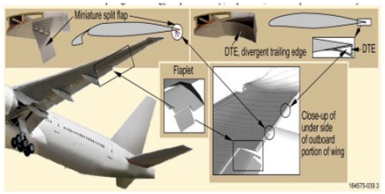
- No compromise in safety
- Successful demonstration
- Quantification of environmental impacts, costs and benefits

Hydroprocessing

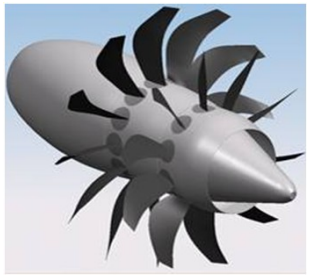
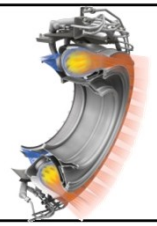
CLEEN Timeframe and Funding

- Timeframe: CY 2010-2014
- Total Budget: $125M (1:1 Cost Share)
- Market Research Conference: May 2008
- Solicitation released: May 12, 2009
- Solicitation closed: July 21, 2009
- Awards Completed: June 22, 2010
- CLEEN Companies: Boeing, GE, Honeywell, P&W and Rolls-Royce

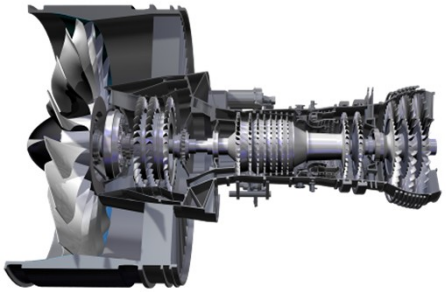
CLEEN Technologies

Company	Technology	Goal Impact
Boeing	Ceramic Matrix Composite Acoustic Nozzle 	Fuel-burn
		Noise
	Adaptable Trailing Edges 	Fuel-burn
		Noise
	Fuel system material swell & fuel absorption	Alt Fuels

CLEEN Technologies

Company	Technology	Goal Impact
GE	Open Rotor 	Fuel-burn
		Noise
	TAPS II Lean Combustor 	Emissions
	Flight Mgt System /Air Traffic Mgt System Optimization	Fuel-burn
		Noise

CLEEN Technologies

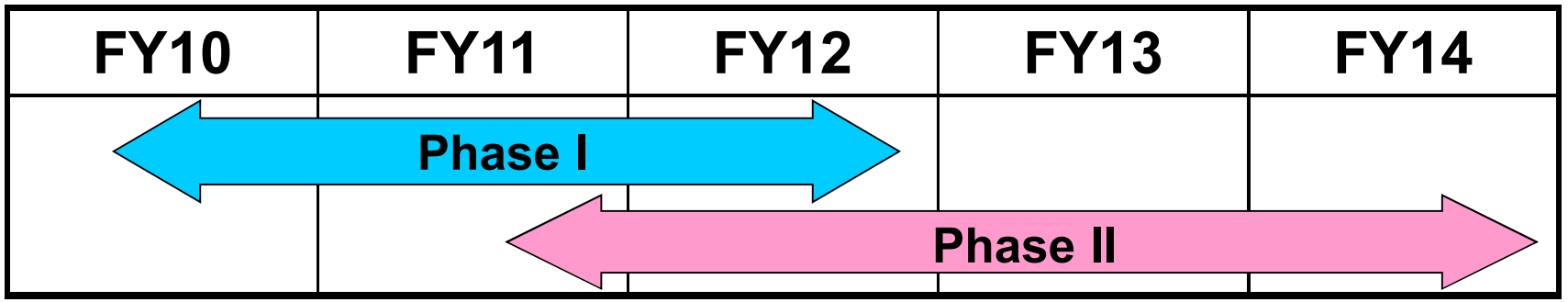
Company	Technology	Goal Impact
Honeywell	Engine weight reduction; high T3 impeller; advanced materials	Fuel-burn
	100% HRJ & bio-aromatic assessments & flt test	Alt Fuels
P&W	Ultra-high Bypass Ratio Geared Turbo Fan 	Fuel-burn
		Emis-sions
		Noise

CLEEN Technologies

Company	Technology	Goal Impact
Rolls-Royce	Dual wall turbine blade	Fuel-burn
	Ceramic Matrix Composite turbine blade tracks	Fuel-burn
	HRJ Characterization & flight test of alternative fuel (business jet)	Alt Fuels
	Engine tests of future alternative fuels (twin-aisle aircraft)	Alt Fuels

Independent Technology Assessment

- **Using Environmental Design Space (EDS) for aircraft and fleet-wide estimates**
- **Two-phase approach**
  - 1st Phase: assess impact of CLEEN technologies on representative aircraft using publicly available data;
  - 2nd Phase: assess specific CLEEN technology impacts using contractor-provided data (proprietary)

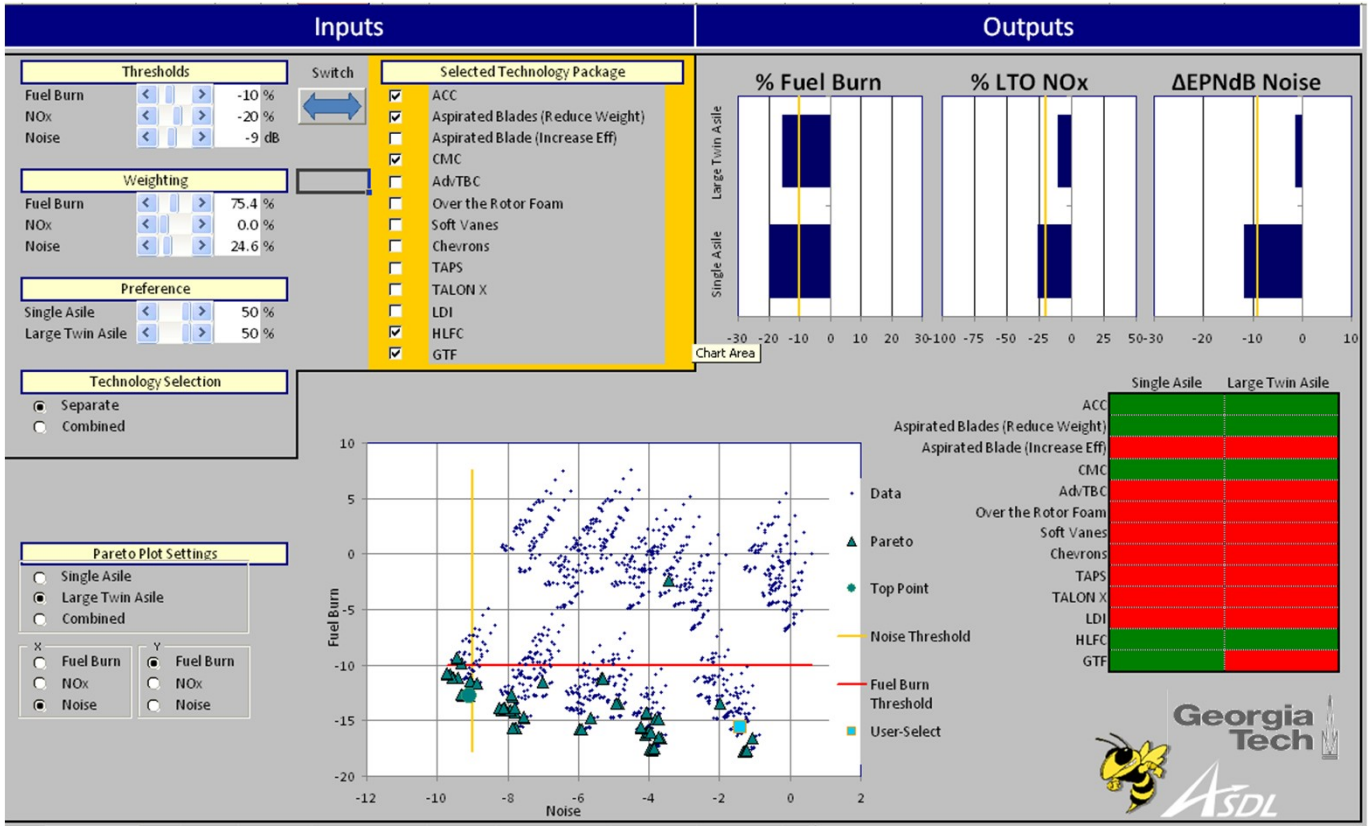


EDS Representative CLEEN Technologies

FUEL BURN	NOISE	EMISSIONS
Retro-fit non-planar wing tips	Landing Gear Fairings	TAPS
Natural laminar flow control	Flap fences/flaplets	Talon X
Open rotor	Fixed Chevrons	HRJ alt fuels
Geared turbofan	Combustor liner	
Active cooling	Variable area nozzle	
Highly loaded compressor	Stator sweep and lean	
Highly loaded turbine	Acoustically soft vane	
Ceramic matrix composites	Aft cowl liners	
Adaptive trailing edge	Zero splice inlet	
FMS controlled flight trajectory	Nose lip liner	
End wall contouring		

Independent Technology Assessment (Con't)

- Assess technology combinations
- Identify synergistic technologies
- Compare to company estimate



CLEEN Consortium

- Semi-annual meeting with government and industry partners
- Provides forum to review progress and address issues
- Plenary session will be open to all attendees and will include overview presentations (unlimited rights version)
- Some open sessions may focus on specific topics in a workshop format

Way Forward

- Address NextGen and National R&D environment and energy goals
- Promote transition of demonstrated technologies to the fleet
- Conduct independent assessment of technologies to evaluate fleet-wide benefits
- Foster qualification/certification of aviation alternative fuels

CLEEN Consortium Goals

- Facilitate cooperation among awardees
- Spur technical interchange
- Provide mechanism for effective government-industry collaboration
- Accelerate technology transition to commercial products
- Provide vehicle to more effectively identify & address technology gaps

Open Plenary Session Agenda

9:00	Boeing
9:40	Break
10:00	GE
10:40	Honeywell
11:20	Pratt & Whitney
Noon	Lunch
1:00	Rolls-Royce
1:40	EDS Presentation (GA Tech)

Open Plenary Session Agenda (Cont)

2:15	Discussion: EDS Phase II Model Integration Approaches
2:45	Break
3:00	Discussion: Future Consortium meetings; Sub-committee formation
5:00	Adjourn